Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Mind.

THERE seems to me now to be some prospect of agreement that, since all characters are equally products of nature (potentiality, capacity, predisposition, diathesis) and fitting nurture, all must be equally innate, acquired, germinal, somatic, and inheritable. *If* that be the case, the problem of inheritance is settled. Doubtless some biologists will continue to discuss such things as the transmission of characters and the intensity of inheritance, but the impossibility of defining their terms and explaining what they mean will always vitiate their labours.

Whatever other tasks biology has before it, two are of prime importance: (*a*) to determine what characters are evoked in individuals by such influences as food, moisture, light, temperature, hormones, use, injury, and the like, and (*b*) to trace the evolution of races, which implies tracing the changes in their natures (*i.e.* in germ-plasms as indicated by changes in characters), which, since the nature of every race is the sum of its potentialities, in turn implies tracing changes in potentialities for development. In both these tasks biology must seek its data from the subsidiary sciences of physiology and psychology.

The kinds of nurture with which we are most familiar, and which we can most easily observe in action, are injury and use. Here, therefore, we are best able to note to what extent individuals are capable of developing in response to given influences, and to what extent species have altered with respect to their capacities for development. Both injury and use confer adaptability on the individual. Injury need not detain us long. Many plants and some lower animals are capable of developing greatly in response to it. Thus a begonia or a sponge may be completely regenerated from a fragment. A lobster can regenerate its claw and a lizard its tail. Higher animals merely heal injuries by means of scars. In them this capacity has undergone retrogression and has been replaced (or supplemented) by that which confers much more adaptability—the capacity of developing in response to use.

It would seem that the power of developing in response to use is a late and a high product of evolution. At any rate, since it is inappreciable in low, and progressively more evolved in higher, animals, presumably it must have had a beginning somewhere in the scale. Presumably also, since a structure cannot be used before it exists, the individual recapitulates in this particular, as in others, the evolution of his race.

The evidence is much clearer as regards mind. I take it that mind is associated with movement; its function is to cause the individual to take action. A reflex action may be associated with consciousness. Some reflex actions (*e.g.* sneezing) are even initiated by consciousness. Some (*e.g.* breathing) can be controlled to some extent by the will; but no reflex action is *initiated* by the will. Thus, when we cough at will the action is not reflex. Reflex actions, therefore, may be defined as those which are initiated by stimuli other than will. On the other hand, an instinct is always and altogether a mental thing—a mental impulse, an emotion, an inclination, a desire to do a certain action, the instinctive action. Like reflexes, it develops in the individual apart from mental experience which merely awakens it to activity, but does not create it. In other words, an instinct is not learned; it is not a product of the functional activity of the mind, but develops in response to quite different influences (*e.g.* hormones). It is not a complex reflex; some reflex actions (*e.g.* sneezing) are quite as complex as some instinctive actions (*e.g.* infantile crying). An instinctive action differs from a reflex action in that it is always *voluntary*. The individual performs the action because he *wants* to do so. If there were no desire, there would be no action. I am aware that all this is unorthodox. Nevertheless, it is true, as any one may discover by examining his own instincts. Does he not, for example, eat, and drink, and sport, and make love through desire? Did he *learn* to feel these desires? I am aware also that at this stage it is customary to discuss the metaphysics of mind and will. I have tried to do so elsewhere, but it is unnecessary here. It is enough that mind, including will, exists and appears to influence the body as gravitation appears (as incomprehensibly) to influence the planets. Instinct may be defined as desire which develops in response to influences other than functional activity.

Habit, intelligence, and reason are in a different category. They are all products of learning, of mental growth due to the functional activity of the mind. An animal is intelligent in proportion as it profits mentally from experience—that is, in proportion as its past sheds a light on, and serves as a guide for, its present and its future. The animal then stores experiences and *re*collects them. Thus its mind grows. We have given a special name to the power of growing mentally in response to use, though the word is used somewhat vaguely. We call it memory. We speak of a man with a good or bad memory, with good or poor powers of learning.

There are two sorts of memory, conscious and subconscious. Again I am unorthodox, but my words have real meanings. We learn two sorts of things: (*a*) facts and the like, which we can recall to mind and which belong to the conscious memory, and (*b*) skill and facility in thinking and doing (mental habits) which cannot in the same sense be recalled, and which, therefore, belong to the subconscious memory. For example, I can recollect a good deal about golf clubs, balls, courses, and adventures; but all this is quite distinct from other sorts of learning, which I cannot in the same sense recall, and, therefore, cannot describe, which enable me to play skilfully (to a humiliatingly small degree). The greatest golfers do not know the very names of the muscles which they have learned to co-ordinate with such exactness and facility.

Consider the caterpillar. He comes out of the egg and, equipped with instincts, at once sets about the business of life. He seeks his food and devours it; he hides from enemies; at the proper time and place he builds a cocoon, and as a butterfly does all sorts of new actions of which also he can have had no previous experience. Apparently he learns nothing; he has little or no memory. Learning would be useless to him; for, unprotected and untaught as he is, he must always act correctly and at once, or perish. He can "bear in mind" for a little while, as a sound lingers on a harp-string. But he cannot recall, as a sound is reproduced by a gramophone. He can feel (*e.g.* pleasure and pain, desire and aversion), but he cannot think (compare, associate, imagine, and the like); for without learning he has nothing to think about. Because his past is a blank he cannot forecast his future, which, therefore, is a blank also. He lives only in the immediate present—a knife-edge of time. Since he has little or no power of profiting by

©1922 Nature Publishing Group

experience, he is not adaptable; he moves in much the same groove as did his ancestors of a million years ago.

Higher than the caterpillar in the animal scale, the power of growing mentally in response to functional activity is clearly in being. Animals are able to recognise mates and offspring, and the latter are able to recognise their guardians. Family life begins. The offspring, more or less helpless at birth, but protected by their guardians, have ability and opportunity to develop physically and mentally in response to functional activity until they are able to fend for themselves. They begin to think, they become adaptable. This evolution culminates in man, who is born so helpless that he cannot even seek the breast, but who learns so enormously that he becomes rational. Reason is merely intelligence *in excelsis*. A vast and complex store of experience then lights a complex, and perhaps distant, future. Compare three human individuals—an idiot, a newly born baby, and a normal man. The idiot cannot learn, and has not learned; the baby can learn, but has not learned; the normal man can learn, and has learned. There in a nutshell is all the mental difference between them, except that the baby has not yet developed a few instincts. The idiot has these instincts, but, probably because he has lacked some hormone, has reverted by mutation (himself or by some progenitor) to an enormously remote ancestry in which the power of learning was defective. One day I think we shall cure idiocy by the injection of the proper glandular extract. Compare a man with a dog: how enormously greater is the human power of learning, and, therefore, of thinking. Compare him with a house-fly: the fly settles on the hand; we strike at it; impelled by instinct, it shoots away; a moment after, having ceased to "bear in mind," it is back again, unmindful of a danger the recollection of which would set a man shuddering for years. We are able to domesticate animals only when they have the capacity to learn to tolerate, to obey, and, when the intelligence is very great (*e.g.* dog), even to love us. Savage man is so intelligent that he has invented language by means of which he is able to hand on the accumulated traditions of generations. Civilised man differs from him in that he has invented aids to his powers of remembering (*e.g.* books of reference), of thinking (*e.g.* mathematics), and of doing (*e.g.* tools). The retrogression of instinct and its replacement by intelligence is well illustrated by maternal care among brutes and men. Among the former it is instinctive, but women have to learn how to tend their young. Again, while insects walk instinctively, men learn. Among the higher animals the number of offspring is controlled by the number which can be protected and taught.

This or that naturalist may disagree as to this or that detail of what I have written about mind, but with the main argument I think all must agree. Already, in practice if not in theory, actions which are not initiated by the will are called reflex; those which are initiated by the will, but in which learning plays no part, are called instinctive; while those which are both initiated by the will and result from learning are called intelligent. As to the evolution of the potentiality of developing in response to use, the truth is glaringly obvious. Even a schoolboy knows that he can teach a beetle nothing, a cat a little, a dog more, and a child much. But all this is incompatible with Lamarck's first law, which has met with such general acceptance. As regards body, the evolution may be more difficult to trace. At any rate, it has not been studied. But as regards mind it is as clear as sunlight. Plainly, an animal is intelligent in proportion as it is able to profit from experience; man's reason and intellect depend wholly on his power of learning; and, as well as I can judge, whenever an animal is capable of learning it is also capable of developing physically in a corresponding degree in response to the stimulus of use.

G. Archdall Reid.

9 Victoria Road South, Southsea, Hants.

Pencil Markings in the Bodleian Library.

In a former communication (Nature, 1920, vol. 105, p. 12) I described a method of distinguishing microscopically between the markings made upon paper with different kinds of pencils, and gave some account of the characteristics of early pencil writings in the British Museum.

I am now indebted to the Librarian of the Bodleian Library and to Dr. Craster for their kindness in giving me facilities for studying similar early specimens of pencil writing in that library.

In Schönemann's work on the examination of early MSS. ("Versuch eines Systems der Diplomatik," 1818, vol. ii. p. 108) it is stated that the ruled lines in various documents of the eleventh and twelfth centuries are in a graphite pigment. Referring to this statement I pointed out (*loc. cit.*) that, since graphite was only discovered in 1560, it was obvious that Schönemann must have mistaken ordinary metallic lead for graphite.

The historical basis for my criticism is to be found in Gesner's "De Rerum Fossilium Lapidum et Gemmarum Genere," 1565, vol. ii. p. 105, and in Beckmann's "Beiträge zur Geschichte der Erfindungen" (1780). It appears, however, that graphite must have been known long before that time, for, after reading my communication, Prof. Flinders Petrie informed me that he had discovered a lump of graphite at Ghorub, which must have dated back to a period between 1500 and 1200 B.C., although there was no evidence that graphite was ever used as a pigment in ancient Egypt.

This unique specimen of graphite, a portion of which Prof. Flinders Petrie has kindly given me for examination, is a decidedly coarse, impure mineral, containing only 39·4 per cent. of carbon, and the amount of silicious impurities present is plainly indicated by the pronounced irregular striations in the markings on paper.

This proof that graphite was known ages before its reputed discovery in 1560 in the Borrowdale mine, gives an added interest to the examination of the earliest pencil markings available in this country.

The earliest known instance of pencil marking in the Bodleian is a vellum MS. Commentary on the Book of Job of the thirteenth century (Auct. D. iii. 14). This has vertical lines, ruled with a stylus down the sides of the writing, and the microscope shows that the pigment of these is lead or other metal.

In the "Opuscula Varia SS. Augustini et Bernardi" of the thirteenth and fourteenth centuries (Hatton MS. 102), the ruled lines surrounding the text are in a red ink in some of the MSS., whilst in others they are in a metallic pigment. In another Hatton MS. (No. 107) of the fourteenth century, no pencil markings are present, the ruled lines at the side and the annotations being in a pale brown ink.

The "Opera Johannis Dastyn" of 1590 (Bodl. MS. 485) is written in ink, and shows pencil strokes at the side written in graphite, but there is no evidence that these markings were contemporaneous with the body of the MS.

An Italian MS. on paper, "Geomantia" (Digby MS. 133), written in ink prior to 1634, shows fine ruled lines at the side in a brilliant metallic pigment;

©1922 Nature Publishing Group